Impact of Non-pharmacological Intervention Policies on COVID-19 Infection

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Abstract: The spread of COVID-19 has caused great distress to people in countries around the world. Pending the development of the special-effect drug that can treat COVID-19, every country in the world has adopted various non-pharmaceutical intervention policies (NPI) to stop the spread of the pandemic and reduce its impact on society. This study used logistic regression to model mortality and infection rates in the two countries, exploring which NPI policies had an impact on the decline in mortality and infection rates in the two countries. This study analyzes the impact of nine NPI policies on COVID-19 infection and mortality rates and found that. Restrictions on international travel policies contributed to the reduction of COVID-19 infection and mortality in both countries. The workplace closure policy and the in-country travel restriction policy contributed to the mitigation of the epidemic in the UK, while for the Chinese government, the home quarantine policy reduced COVID-19 mortality and infection rates. Overall, the NPI policy enacted by the Chinese government line was more stringent compared to the UK. Governments should carefully consider enacting stricter international travel restriction policies in the event of future epidemics. In terms of the timing of the policy, a long-term NPI policy would be more effective in controlling epidemics.

Keywords**:** COVID-19; non-pharmacological intervention policies; face mask; international travel bans

1. Introduction

The World Health Organization (WHO) declared COVID-19 a "public health emergency of international concern" on 30 January 2020 and elevated it to a pandemic on 11 March 2020[1]. The COVID-19 pandemic has exerted a profound impact on individuals, institutions, and governments globally. According to Our World in Data (2022)[2], as of March 18, 2022, the cumulative number of diagnosed cases has surpassed 400 million, with the cumulative number of deaths exceeding 6 million. Common symptoms of COVID-19 resemble those of the common cold, encompassing fever, cough, and fatigue. Nevertheless, severe cases may manifest symptoms such as breathlessness, shortness of breath, and loss of speech or mobility[1].

COVID-19 is primarily transmitted through saliva emitted by patients during coughing, sneezing, or speaking[1]. These saliva droplets can adhere to surfaces, leading to infection if individuals come into contact with these surfaces or an infected person (World Health Organization [WHO], 2022)[1]. Moreover, the virus undergoes mutations, undergoing constant changes over time. Within just two years, 5 Variants of Concerns (VOCs) and 8 Variants of Interest (VOIs) have emerged (World Health Organization [WHO], 2022)[1]. The mutated COVID-19 enables transmission even by asymptomatic individuals (World Health Organization [WHO], 2022)[1].

Non-pharmacological interventions (NPIs) currently constitute a pivotal approach to COVID-19 pandemic suppression strategies in diverse countries. NPI is a comprehensive top-down (i.e., governmental) and bottom-up (i.e., self-initiated) initiative aimed at interrupting the chain of infection at the transmission route level by modifying people's behaviors [3]. The principal NPIs currently implemented in most countries include school closures, social distancing measures, and public transport restrictions[3-9]. These measures contribute to curtailing COVID-19 spread by minimizing person-to-person proximity contact, thereby severing as many transmission routes as possible. According to WHO (WHO, 2022) [1] data from several countries with widespread VOC transmission, non-pharmaceutical interventions such as infection prevention measures, testing, and other strategies have proven effective in reducing COVID-19 cases, hospitalizations, and deaths. China, being the first country to experience a COVID-19 outbreak, has implemented stringent policy interventions. The Chinese experience suggests that isolating infected populations, practicing social distancing, and implementing quarantines can effectively contain outbreaks[4]. Despite criticism of China's initial handling of the COVID-19 outbreak, by early March 2020, China had successfully controlled the virus's spread (Hui, 2020) [5]. In contrast, the UK's approach to COVID-19 has been contentious. The measures taken by the UK government, based on past influenza management experiences and supported by scientific advice, aimed to control the epidemic and achieve herd immunity through infection[6]. British scientists altered their advice in early March 2020, and the government waited an additional week before announcing city closures (Cabinet Office, 2021) [7]. These policies contributed to the UK being among the countries most severely affected by the COVID-19 pandemic.

Our World in Data (2022) [1] digitizes various policy responses to interventions into the stringency index. The stringency index is computed by amalgamating nine indicators, including school closures, workplace shutdowns, cancellation of public events, and restrictions on public gatherings [8]. Over the two years of the COVID-19 pandemic, the timing and causes of outbreaks have varied from country to country. Consequently, different countries have adopted diverse strategies, yielding disparate outcomes in terms of COVID-19 infection and mortality rates. This study will concentrate on analyzing COVID-19 policies in China and the UK. In alignment with the objectives of this study, the research questions are as follows.

1. How common is the use of non-pharmacological intervention policies in the UK and China?

2. What are the main non-pharmacological intervention policy factors influencing COVID-19 mortality and infection rates in the UK and China?

3. Which non-pharmacological intervention policies have less impact on COVID-19 infection and mortality rates in China and the UK?

2. Materials and Methods

2.1 Data Collection, Research Variables and Their Definitions

The data utilized in this investigation originate from the Coronavirus Pandemic (COVID-19) section of Our World in Data. The dataset is accessible for download at https://ourworldindata.org/coronavirus. Our World in Data's COVID-19 dataset encapsulates a comprehensive collection of data related to the outbreak in a time-series format, encompassing metrics such as deaths, infections, hospitalizations, intensive care units, testing, vaccinations, and national policies[2]. Specifically, for this study, data concerning the number of infections, and tests in both the UK and China will be employed. It is important to note that, based on the compilation of the OWID dataset, there are slight variations in the dates of data collection between China and the UK. This study incorporates data relevant to the UK spanning from 31 January 2020 to 25 July 2022, whereas the pertinent data for China spans from 22 January 2020 to 31 July 2022[3].

The independent variables in this study consist of various Non-Pharmacological Intervention (NPI) data. The NPI data for this study were sourced from the Oxford Covid-19 Government Response Tracker (OxCGRT). OxCGRT systematically collects information on policy measures implemented by governments across over 180 countries in response to COVID-19, coding the gathered data into 23 indicators (Oxford, 2021) [13]. These 23 real-time indicators are categorized into four types: containment and closure policies, economic policies, health system policies, and vaccine policies. Aligning with the research objectives of this study, the primary independent variables encompass (1) School closures; (2) Workplace closures; (3) Cancellation of public events; (4) Restrictions on public gatherings; (5) Face coverings; (6) Stay-at-home restrictions; (7) Public transport; (8) Internal mobility restrictions; and (9) International travel bans.

Before these independent variables can be utilized, they necessitate recording. To facilitate logistic regression, mortality and infection rates must be discretized. In this study, the mean values of the infection rate and mortality rate were employed as threshold values. Infection and mortality rates exceeding the mean are categorized as 'high infection' and 'high mortality,' while rates below the mean are labeled as "low infection" and "low mortality." Following categorization, these values are encoded as 0 and 1 and applied to the dataset. Additionally, it is imperative to consider the time lag between infection from the virus. The average lag time between virus transmission and symptom onset is 6 days (Bi, 2020) [9,10]. This temporal aspect implies that same-day policies influence infection rates 6 days later and mortality rates 18 days later. Consequently, when constructing the dataset, this study will stagger infection and mortality rates based on dates. For instance, for a policy implemented on 1 March 2020, the resulting infection rate pertains to 6 March, and the mortality rate corresponds to 18 March. Post-consolidation of the data, the dataset for this study comprises 15 variables, with the names and meanings of these variables delineated below.

Table 1. Variable names and significance of variables

No.	Variables	Variable Meaning
1	date	Date
2	total_cases	Total number of infections
3	new_cases	Number of new infections today
4	new_cases_per_million	Number of infections per million people
5	low infection rate/high infection rate	Infection rate compared to new_cases_per_million mean (high is 1, low is 0)
6	low infection rate/high infection rate (Removal of time effects)	Relative infection rate after removing the effect of time (high is 1, low is 0)
7	school_closures	Government policy on school closure
8	workplace_closures	Government policy on workplace closures
9	cancel_public_events	Government policy on cancellation of public events
10	restriction_gatherings	Government Policy on Restrictions on Public Meetings
11	stay_home_requirements	Government policy on home requirements or home blocking
12	facial_coverings	Government policy on the use of face masks in the outdoors
13	close_public_transport	Government policy on public transport closures
14	restrictions_internal_movements	Government policy on restricting internal-regional and inter-city movement/travel
15	international_travel_controls	Government policy on restrictions on international travel control

2.2 Statistical Analysis

Infection and mortality rates in this study are continuous variables and descriptive statistics will be used to calculate their mean, median, plurality and variance. For the other categorical variables, frequency, percentage and plural will be counted in this study.

one dependent variables (new cases/per million) and nine independent variables will be tested separately by chi-square tests to verify their correlation. The total of 36 original hypotheses are set up for the relationship between the four dependent and the nine independent variables. The chi-square test results are checked and the $p<0.05$ indicates that the original hypothesis is rejected and there is a correlation between the two variables.

This study will use the full data to build separate logistic regression models for mortality and infection rates for both countries to see the overall situation in both countries. The formula for binary logistic regression is as follows.

$$Y = \begin{cases} 1(\text{high mortality and high infection rates}) \\ 0(\text{low mortality and low infection rates}) \end{cases} \quad (1)$$

Where 1 represents high mortality and high infection rates where infection and mortality rates are above the mean and 0 represents low mortality and low infection rates where infection and mortality rates are below the mean.

$$\log i\,(\pi) = h\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_m X_m \quad (2)$$

The probability of Y=1 is π and the probability of Y=0 is (1 - π). β_0 is a constant term; β_1, β_2, β_3, ..., β_m are the regression coefficients of the corresponding influencing factors (independent variables); X_1, X_2, X_3, ..., Xm are the independent variables.

2.3 Research Ethical Stance

Firstly, the study ensured the quality and integrity of the data throughout the research process. Secondly, the secondary data used in this study are from open-source data, and the authors of the dataset and the research institution have indicated that anyone has the right to use, distribute and reproduce the content in any media, subject to attribution and authorship. In addition, the data used in this study do not involve the personal information of human participants. The secondary data subjects used in this study are government-related data and there are no human participants.

3. Results

3.1 NPIs Policy Statistics in the UK and China

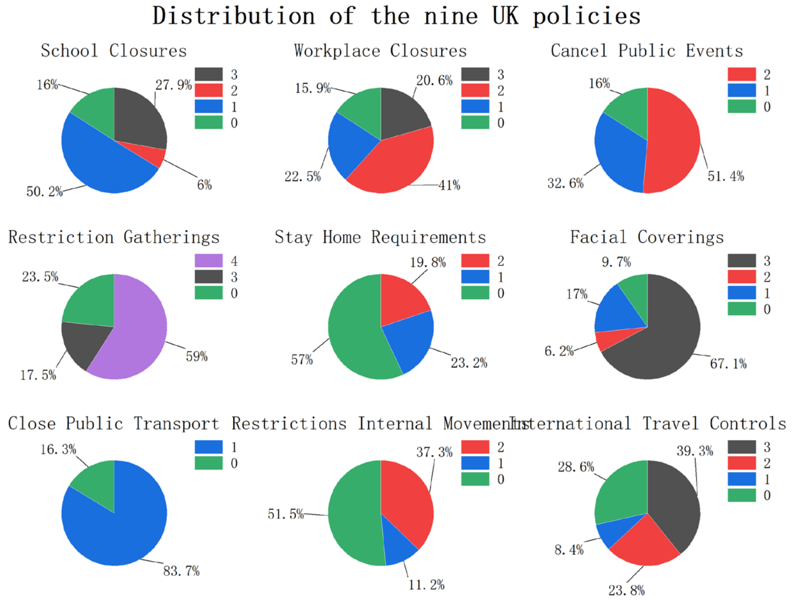

Figure 1. Distribution of the nine UK policies

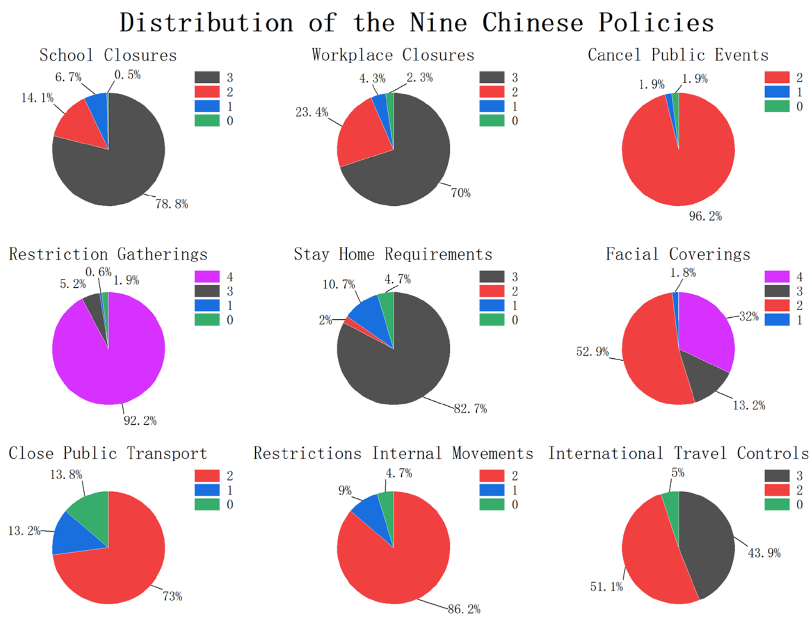

Figure 2. Distribution of the nine Chinese policies

As illustrated in the graph above, it is not uncommon for the UK to have no implemented measures during the recorded data period. Among the nine policies, home restriction and domestic travel restriction are the most lenient, with the UK not having enacted these two policies for over 50% of the time. Additionally, following the enactment of these nine policies, there is a slight variation in their stringency. The most stringent policy is the Restriction of Public Gatherings, with the UK government imposing the most stringent requirements on restricting public gatherings for more than half of the time.

In contrast, the implementation of NPIs policies in China was highly timely during the recorded period of the COVID-19 outbreak. The only three policies that were not implemented throughout the entire outbreak period were home quarantine, internal and external travel restrictions, and closure of public transport. None of the nine policies remained recommended most of the time. The two policies of canceling public events and closing workplaces were the most frequently requested, at over 50% and about a third of the time, respectively. Inbound and outbound travel restrictions, as well as home quarantine policies, were also in the requested status for a higher proportion of the time. Mask-wearing policies are notably stringent in China, with citizens being required to wear masks at all times for more than two-thirds of the time.

Table 2. Frequency statistics for the nine policies in UK and China

NPIs	Valid	UK Frequency	UK Percent	China Frequency	China Percent
cancel_public_events	0	145	16	0	0
	1	296	32.6	21	2.3
	2	466	51.4	901	97.7
	Total	907	100	922	100
close_public_transport	0	16.3	148	272	29.5
	1	83.7	759	155	16.8
	Total	907	100	495	53.7
facial_coverings	0	88	9.7	922	100
	1	154	17	579	62.8
	2	56	6.2	62	6.7
	3	609	67. 1	281	30.5
	Total	907	100	922	100
international_travel_controls	0	259	28.6	34	3.7
	1	76	8.4	407	44. 1
	2	216	23.8	481	52.2
	3	356	39.3	922	100
	Total	907	100	7	0.8
restriction_gatherings	0	213	23.5	33	3.6
	3	159	17.5	882	95.7
	4	535	59	922	100
	Total	907	100	12	1.3
restrictions_internal_ movements	0	467	51.5	144	15.6
	1	102	11.2	766	83. 1
	2	338	37.3	922	100
	Total	907	100	4	0.4
school_closures	0	145	16	88	9.5
	1	455	50.2	154	16.7
	2	54	6	676	73.3
	3	253	27.9	922	100
	Total	907	100	30	3.3
stay_home_requirements	0	517	57	157	17
	1	210	23.2	60	6.5
	2	180	19.8	675	73.2
	Total	907	100	922	100
workplace_closures	0	144	15.9	4	0.4
	1	194	21.4	34	3.7
	2	382	42. 1	320	34.7
	3	187	20.6	564	61.2
	Total	907	100	922	100

3.2 COVID-19 infection rates in the UK and China

Over the two-and-a-half-year period for which statistics are available, there has been an overall consistent upward trend in the number of infections in the UK. Notably, the number of infections in the UK experienced rapid surges during the periods from September 2020 to March 2021 and November 2021 to April 2022. The occurrences of new infections in the

UK exhibited wide fluctuations throughout the outbreak. From the middle of 2021 until the end of 2021, the number of new infections per day displayed a fluctuating upward trend. Conversely, from mid-December 2021 to early January 2022, the number of new infections per day suddenly increased rapidly, reaching a staggering 220,000 infections per day on January 4, 2022. The pronounced fluctuations in the data from March 5, 2022, to July 21, 2022, are notable and may be correlated with the UK's policy shift, no longer offering free testing for new coronaviruses to the population on April 1, 2022.

The total number of COVID-19 infections in China demonstrated a clear upward trajectory in the early stages of the outbreak. Across the two years from March 2020 to February 2022, the number of infections in China increased gradually. However, from March 2022 to May 2022, there was a sudden surge in the number of infections in China. Within just two months, the number of infections soared from around 150,000 to almost 900,000. The overall trend in the number of daily infections in China remained relatively flat and low, averaging around 100 overall. Daily infections only exhibited an outbreak trend during the initial month of the outbreak and from March 2022 to April 2022. Furthermore, the outbreak in China was effectively controlled, with the number of daily infections rapidly decreasing to normal levels from March 2020 to April to May 2022.

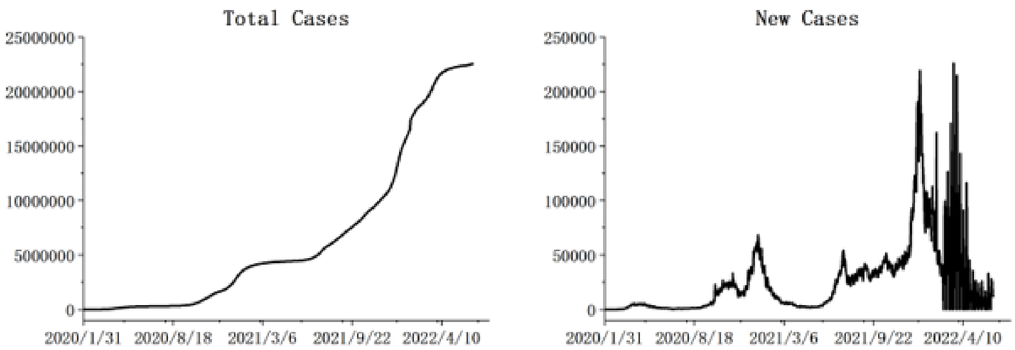

Figure 3. Overview of COVID-19 in the UK

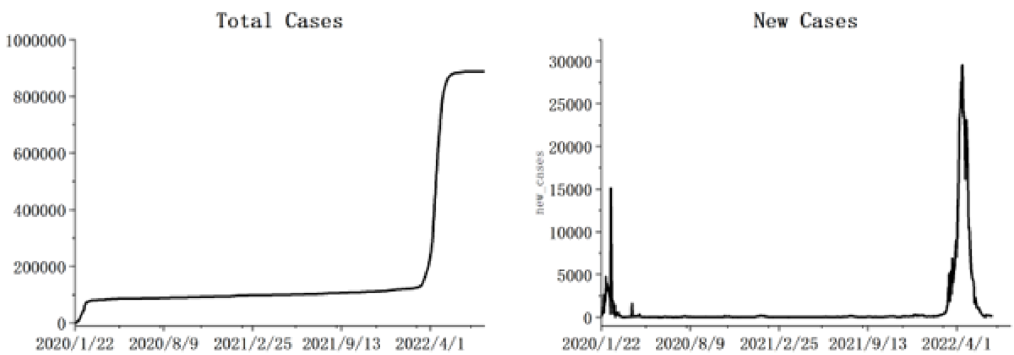

Figure 4. Overview of COVID-19 in China

Table 3. Frequency statistics for COVID-19 infection rates in The UK and China (discretized and eliminated for time effects)

Country	Valid	Frequency	Percent	Valid Percent
	0 (low infection rate)	484	53.4	53.7
UK	1 (high infection rate)	417	46.0	46.3
	Total	901	99.3	100.0
	0 (low infection rate)	826	89.6	89.6
China	1 (high infection rate)	96	10.4	10.4
	Total	922	100.0	100.0

3.3 Chi-square Tests Results

Table 4. Chi-Square Tests results

Title	NPIs	Pearson Chi-Square Value	df	Asymptotic Significance (2-sided)
UK Infection Rate	cancel_public_events	301.312	2	0
	close_public_transport	55.755	1	0
	facial_coverings	255.61	3	0
	international_travel_controls	173.105	3	0
	restriction_gatherings	219.364	2	0
	restrictions_internal_movements	160.291	2	0
	school_closures	232.845	3	0
	stay_home_requirements	111.442	2	0
	workplace_closures	204.536	3	0
China Infection Rate	cancel_public_events	2.516	1	0.113
	close_public_transport	55.508	2	0
	facial_coverings	120.676	2	0
	international_travel_controls	180.526	2	0
	restriction_gatherings	4.897	2	0.086
	restrictions_internal_movements	0.63	2	0.73
	school_closures	54.336	3	0
	stay_home_requirements	28.292	3	0
	workplace_closures	25.007	3	0

As can be seen from the table above, the p-values of all the chi-square tests for mortality and infection rates in the UK are less than 0.05, which indicates that all the original hypotheses have been rejected. All these independent variables are correlated with the dependent variable. For the chi-square test on infection rates in China, the p-values for the three policies of cancelling public events, restricting congregation and restricting internal mobility are all greater than 0.05, which suggests that these three policies are not related to infection rates in China. In the chi-square test for mortality in China, the p-values for the three policies of cancelling public events, restricting aggregation, and the stay-at-home requirement were all greater than 0.05, suggesting that these three values were not associated with mortality from COVID-19 in China. Although the correlation of these policies was not significant, there was a logical relationship between them and the infection and mortality rates. Therefore, these NPIs were still included in the logistic regression model in this study.

3.4 Logistic Regression Analysis (COVID-19 infection rates in the UK and China)

Table 5. Model summary, R Square results for UK and Chinese infection rate

Model	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
UK Infection Rate	616.471	0.502	0.67
Chinese Infection Rate	303.819	0.288	0.589

Table 6. Logistic Regression model results for infection rates in the UK and China

Model	Variables in the Equation	B	df	Sig.	Exp(B)	95%C.I.for EXP(B)	
						Lower	Upper
UK Infection Rate	cancel_public_events	-2.546	1	0	0.078	0.027	0.23
	close_public_transport	-37.614	1	0.991	0	0	.
	facial_coverings	21.764	1	0.989	2832254007	0	.
	international_travel_controls	-0.648	1	0.035	0.523	0.286	0.956
	restriction_gatherings	1.39	1	0	4.015	2.665	6.048
	restrictions_internal_movements	- 1.317	1	0	0.268	0.151	0.475
	school_closures	1.685	1	0	5.39	3.116	9.322
	stay_home_requirements	0.945	1	0.024	2.572	1.134	5.83
	workplace_closures	-2.614	1	0	0.073	0.024	0.222
	Constant	-22.787	1	0.988	0		

Model	Variables in the Equation	B	df	Sig.	Exp(B)	95%C.I.for EXP(B)	
						Lower	Upper
Chinese Infection Rate	cancel_public_events	12.425	1	0.999	249058.515	0	.
	close_public_transport	-0.643	1	0.106	0.526	0.241	1.145
	facial_coverings	3.345	1	0	28.353	8.465	94.968
	international_travel_controls	-2.693	1	0	0.068	0.033	0.138
	restriction_gatherings	15.393	1	0.997	4842824.289	0	.
	restrictions_internal_movements	-0.101	1	0.78	0.904	0.444	1.838
	school_closures	2.547	1	0	12.769	3.307	49.31
	stay_home_requirements	-2.312	1	0	0.099	0.035	0.282
	workplace_closures	-0.648	1	0.232	0.523	0.181	1.513
	Constant	-92.602	1	0.997	0		

The results in the table above indicate that there was no significant association between public transport closure policy (p=0.991), mask-wearing policy (p = 0.989) and COVID-19 infection rates in the UK. The regression coefficients for the public event cancellation policy (p<0.001), the international travel restriction policy (p = 0.035), the restriction of domestic movement policy (p<0.001) and the workplace closure policy (p < 0.001) were negative and can therefore be interpreted to mean that these four NPIs significantly reduced the prevalence of COVID-19 infection in the UK. Each additional level of these four policies reduces the infection rate by 0.078 times the previous rate (public event removal policy), 0.523 times (international travel restriction policy), 0.268 times (domestic movement restriction policy), and 0.073 times (workplace closure policy), respectively. Furthermore, based on the results in Table 4.13, the model can explain between 50.2% and 67% of the variation in infection rates in the UK.

The results in the table above indicate a significant association between the mask-wearing policy (p<0.001), the international travel restriction policy (p<0.001), the school closure policy (p<0.001), the home quarantine policy (p<0.001) and the prevalence of COVID-19 in China. The regression coefficients for the international travel restriction policy (p<0.001) and the home isolation policy (p<0.001) were negative and therefore can be explained by the fact that these two NPIs significantly reduced COVID-19 infections in China. The mortality rate was reduced by 0.068 times (international travel restriction policy) and 0.099 times (home isolation policy) for each additional level of these two policies, respectively. Furthermore, according to the results in Table 4.17, the model explains between 28.8% and 58.9% of the variation in infection rate in China.

4. Discussion

4.1 COVID-19 profiles and NPIs policy enactment in the UK and China

The visualization in section 3.1 indicates that China consistently implemented all nine Non-Pharmacological Interventions (NPIs) concurrently for the majority of the time, with only a few policies not being enacted within 20% of the time. Furthermore, China consistently implemented more stringent NPIs policies. The policies of Cancelation of Public Events and Public Transport Closure, Wearing of Masks, and Domestic Travel Restrictions were all enforced at Level 2 for more than 50% of the time. Even the International Travel Restriction Policy, School Closure Policy, Home Requirements Policy, and Workplace Closure Policy were implemented at Level 3 for more than 50% of the time. The combined effect of these factors may contribute to explaining the comparatively lower COVID-19 mortality and infection rates in China compared to the UK. In contrast, the UK did not consistently implement NPIs, with the home requirement policy and the restriction of domestic movement policy not even being enacted for more than 50% of the time. Moreover, even during the periods when NPIs were implemented, most of these policies were maintained at a low recommended level. Only the Restriction on Aggregation Policy was required to be at Level 4 for more than 50% of the time. It appears that the delayed implementation of these policies might contribute to a COVID-19 outbreak and higher infection and mortality rates in the UK.

4.2 The impact of NPIs on COVID-19

To assess the impact of Non-Pharmacological Interventions (NPIs) policies on mortality and infection rates in both countries, this study developed a logistic regression model. In contrast to the findings of Chinazzi (2020)[11], the results of the regression model in this study suggest that international travel restriction policies played a significant role in reducing infection and mortality rates in both countries. Despite the potential impact on the international spread of COVID-19 outbreaks, as proposed by Devi (2020)[11], restricting international travel can effectively prevent the virus from entering the country at the onset of its transmission, serving as a crucial method for limiting virus invasion.

Moreover, the decrease in infection and mortality rates in the UK is directly linked to the implementation of the

Cancellation of Public Events Policy, the Domestic Travel Restriction Policy, and the Workplace Closure Policy. This aligns with the findings of Borjas (2020) and Haug (2020)[12]. These policies significantly curtail person-to-person contact and restrict the transmission route of the virus, thereby limiting the spread of COVID-19. In contrast, in China, the reduction in COVID-19 infection rates is associated with the implementation of a home isolation policy. The home isolation policy in China remained at the most stringent level for the majority of the epidemic, suggesting that a prolonged and rigorous home isolation policy contributed to the decline in COVID-19 infection rates.

An intriguing finding is that the implementation of the mask-wearing policy did not impact the reduction of COVID-19 mortality and infection rates in both China and the UK. This corresponds to the findings of Feng (2020)[12] but contradicts the findings of Ding (2021)[13]. A plausible explanation for this might be the lack of public awareness to wear masks even after the enactment of a national policy mandating mask-wearing, attributed to insufficient regulatory efforts and public understanding of the science behind it (Goldberg, 2020)[14]. Furthermore, the results of this study indicate that the school closure policy also did not contribute to mortality and infection rates in both countries, consistent with the findings of Anderson (2020)[15]. A plausible explanation is that incomplete NPIs policies may lead to suboptimal outcomes, and sustained, long-term NPIs policies are likely to have a positive impact on the control of COVID-19 spread (Althouse, 2020)[5].

5. Conclusions

This study reveals that China's Non-Pharmaceutical Interventions (NPIs) policy has generally been more stringent compared to the UK's NPIs policy, particularly concerning domestic and international travel restriction policies, home quarantine policies, and school closure policies. This aligns with the overall more favorable COVID-19 epidemic situation observed in China compared to the UK. Additionally, the effectiveness of long-term and sustained non-pharmaceutical intervention policies in mitigating the COVID-19 epidemic is underscored. Therefore, governments should carefully consider implementing more stringent and sustained NPIs policies. The findings indicate that public event cancellation policies, restricted international travel policies, restricted in-country policies, and workplace closure policies had an impact on mitigating the COVID-19 epidemic in the UK. In contrast, for China, the home quarantine policy proved effective in reducing COVID-19 infection rates. The study further identifies those policies restricting international travel were associated with decreases in mortality and infection rates in both countries. In potential future outbreaks, governments could consider implementing early entry restrictions on individuals from countries with COVID-19 outbreaks and restricting their citizens from traveling to countries experiencing outbreaks.

Moreover, the study reveals that the implementation of the mask-wearing policy and school closure policy had no discernible impact on mitigating the COVID-19 outbreak in the two countries. This observation may be attributed to the government's policy monitoring system and civic education campaigns. In future outbreak prevention and control efforts, governments could enhance policy advocacy and monitoring tools for NPIs to raise citizens' awareness of COVID-19 preparedness. Subsequent research could delve into a more detailed examination of the monitoring system for NPIs policies and public education on COVID-19 science. Further investigation into public perceptions and reactions to NPIs policies could be instrumental in understanding the public's ability to comply with such policies. Additionally, the impact of vaccination on the effectiveness of NPIs policies in addressing COVID-19 warrants exploration. Subsequent studies could analyze the time before and after vaccination separately for different countries.

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